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IS/QC 720100-12 (2001): Semiconductor Devices, Part 12:
Sectional Optoelectronic Devices [LITD 5: Semiconductor and
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भारतीय मानक
अर्द्धचालक युक्तियाँ
भाग 12 ऑप्टोइलेक्ट्रॉनिक युक्तियों के लिए खण्ड विशिष्ट

Indian Standard
SEMICONDUCTOR DEVICES
PART 12 SECTIONAL SPECIFICATION FOR OPTOELECTRONIC DEVICES

ICS 31.260

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

NATIONAL FOREWORD

This Indian Standard which is identical with IEC 747-12 (1991) ‘Semiconductor devices — Part 12 : Sectional specification for optoelectronic devices’, issued by the International Electrotechnical Commission (IEC), was adopted by the Bureau of Indian Standards on the recommendations of Semiconductor Devices and Integrated Circuits Sectional Committee and approval of the Electronics and Telecommunication Division Council.

This standard covers the details of quality assessment procedures, the inspection requirements, screening sequences, sampling requirements, test and measurement procedures required for semiconductor optoelectronic devices.

The text of the IEC has been approved as suitable for publication as Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

- a) Wherever the words ‘International Standard’ appear referring to this standard, they should be read as ‘Indian Standard’.
- b) Comma (,) has been used as a decimal marker while in Indian Standards the current practice is to use a point (.) as the decimal marker.

CROSS REFERENCES

In the adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their place are listed below along with their degree of equivalence for the editions indicated:

<i>International Standard</i>	<i>Corresponding Indian Standard</i>	<i>Degree of Equivalence</i>
IEC 68-2-14 (1984) Environmental testing — Part 2 : Tests — Test N : Change of temperature	IS 9000 (Part 14) : 1988 Basic environmental testing procedures for electrical and electronics items: Part 14 Test N: Change of temperature	Technically equivalent
IEC 747-1 (1983) Semiconductor devices — Discrete devices and integrated circuits — Part 1 : General	IS 14901 (Part 1) : 2001 Semiconductor devices — Discrete devices and integrated circuits: Part 1 General	Identical
IEC 744-3 (1985) Semiconductor devices — Discrete devices — Part 3 : Signal (including switching) and regulator diodes Amendment 1 (1991)	IS 14901 (Part 3) : 2001 Semiconductor devices — Discrete devices and integrated circuits: Part 3 Signal (including switching) and regulator diodes	do
IEC QC 001002 (1998) Rules of procedure of the IEC quality system for electronic components (IECQ)	IS QC 001002 : 1998 Rules of procedure of the IEC quality system for electronic components (IECQ)	do

The concerned technical committee responsible for preparation of this standard has reviewed the provisions of the following International Publications and has decided that they are acceptable for use in conjunction with this standard:

Indian Standard

SEMICONDUCTOR DEVICES

PART 12 SECTIONAL SPECIFICATION FOR OPTOELECTRONIC DEVICES

1 Scope

This sectional specification applies to the following:

- semiconductor photoemitters:
optoelectronic displays;
light-emitting diodes (LED);
infrared-emitting diodes (IRED);
laser diodes.
- Semiconductor photosensitive devices:
photodiodes;
phototransistors;
photothyristors.
- Semiconductor imaging devices.
- Photocouplers, optocouplers.

2 General

This specification shall be read together with the generic specification to which it refers; it gives details of the quality assessment procedures, the inspection requirements, screening sequences, sampling requirements, test and measurement procedures required for semiconductor optoelectronic devices.

2.1 *Related document*

IEC 747-10/QC 700000, Semiconductor devices – Part 10: Generic specification for discrete devices and integrated circuits.

2.2 *Recommended values of temperatures (preferred values)*

See IEC 747-1, chapter VI, clause 5.

2.3 *Recommended values of voltages and currents (preferred values)*

See IEC 747-1, chapter VI, clause 6.

2.4 *Terminal Identification*

The terminal identification shall be as given in the detail specification.

3 Quality assessment procedures

3.1 *Primary stage of manufacture and subcontracting*

The primary stage of manufacture is one of the following:

- for monocrystalline semiconductor devices
"The first process that changes the monocrystalline semiconductor material from being wholly P-type or N-type";
- for polycrystalline semiconductor devices
"The deposition of a polycrystalline layer onto a substrate".

3.2 *Structurally similar devices*

The crucial criterion for the grouping of types of devices as structurally similar is that the differences between the various types have no influence on the results of the test for which the group has been formed.

For the purpose of this specification, structurally similar devices are produced by one manufacturer, essentially according to the same design, with the same materials, processes and methods. They only differ because of manufacturing variations usually resulting in their classification into types having different electrical, photometric or radio-metric characteristics.

For the purposes of obtaining samples both for qualification approval and for quality conformance testing, semiconductor optoelectronic devices *may* be grouped as described below.

The application of these rules is illustrated in the diagrams of appendix A.

3.2.1 *Grouping for electrical and optical characteristic tests in Groups A and/or B*

Components having the same device design, manufactured on the same production line but differing only by a selection based on electrical and optical characteristic limits shall be grouped into sub-lots of types according to these different electrical and optical characteristic limits (that is divided into types).

Such components should preferably be included in the same detail specification but in any case the details of the grouping used shall be explained in the qualification approval test report.

3.2.1.1 *Different electrical and optical characteristic limits*

For those particular tests where different electrical and optical characteristic limits apply for the sub-lots, each sub-lot shall be sampled with a sample size appropriate to the number of components in each sub-lot.

Examples of such particular tests are:

- the selection of photosensitive devices into various sub-lots with different photo-sensitivities;
- the selection of photocouplers into various sub-lots with different output to input transfer ratio;
- the selection of light emitting devices into various sub-lots with different luminous or radiant intensity.

3.2.1.2 *Identical electrical and optical characteristic limits*

For those particular tests where the same electrical or optical characteristic limit and test conditions apply for all the sub-lots, then the total lot shall be assessed by testing either:

- a single sample, of a size appropriate to that for the total lot, comprising equal or proportionate quantities of all the sub-lots, or
- a single sample, of a size appropriate to that for the total lot, taken at random from the total lot.

3.2.2 *Grouping for environmental and mechanical tests in Groups B and/or C*

Components that have been encapsulated by the same method, have the same basic type of internal mechanical structure, have been made with identical piece parts and have been subjected to common sealing and finishing processes may be considered as structurally similar, as described below. A single sample, of a size appropriate to that of the total lot, may be taken to assess the total lot of such similar components.

NOTE - "Identical piece parts" means that the piece parts have been manufactured or procured and accepted to the same drawing or specification.

3.2.2.1 *Devices made on identical production lines*

The tests to which the above grouping may apply are:

- a) visual inspection;
- b) dimensions;
- c) solderability and resistance to soldering heat;
- d) robustness of terminations;
- e) corrosion (for example damp heat, steady-state);
- f) change of temperature and damp heat, cyclic (or sealing);
- g) vibration;
- h) acceleration (steady-state);
- i) shock.

NOTES

1 "Identical production lines" means lines that have equivalent equipment, have identical process control drawings or specifications, use identical piece parts and materials, are located in the same geographical site and are capable of producing identical devices.

2 Examples of such devices are those made on identical production lines and encapsulated in cases made with identical piece parts.

3.2.2.2 *Devices made on different production lines*

The tests to which the above grouping may apply are limited to:

- a) visual inspection;
- b) dimensions;
- c) solderability and resistance to soldering heat;
- d) robustness of terminations;
- e) corrosion (for example damp heat, steady-state).

3.2.3 *Grouping for endurance tests*

Unless otherwise specified in the detail specification, for endurance tests such as

- electrical endurance and
- dry heat,

components having the same device design, manufactured on the same production line but differing only by a selection based on electrical and optical characteristic limits, shall be divided into sub-lots of types according to those different electrical and optical characteristic limits. Devices from one of these sub-lots may be used for electrical endurance tests in accordance with subclauses 3.2.3.1 or 3.2.3.2.

Such devices should preferably be included in the same detail specification, but in any case the details of the grouping used shall be declared in the qualification approval test report.

3.2.3.1 *Tests specified in Group B (lot by lot)*

The total lot may be assessed for each type of endurance test by taking a single sample, of a size appropriate to that of the total lot, from any sub-lot provided that:

- the total quantity of devices in the sub-lot chosen, together with the total quantity of devices in all the other sub-lots that have either a lower rating or a less severe characteristic limit, comprise not less than 60 % of the total lot size of all the sub-lots, and
- in production, during the preceding three months, electrical endurance tests have been performed on the sub-lot having either the highest rating or the most severe electrical or optical characteristic limits, within the total lot, and that lot has been offered for inspection during that period using the appropriate sample size.

3.2.3.2 *Tests only specified in Group C (periodic)*

For each type of periodic endurance test, the total lot may be assessed by taking a single sample of the size specified in the detail specification, preferably from the sub-lot containing the greatest number of devices, but also assuring adequate rotation of other types over a longer period.

3.3 *Inspection requirements for qualification approval*

Method b) of Rules of Procedures, subclause 11.3.1 of IEC Publication QC 001002 shall normally be used with the sampling requirements in accordance with those stated in tables V and VI of this specification.

It is however permitted to use method a) of IEC Publication QC 001002, sub-clause 11.3.1, provided the sampling requirements to be used are specified in the relevant blank detail specification.

3.4 *Quality conformance inspection*

3.4.1 *Division into groups and sub-groups*

The division into groups and sub-groups shall be in accordance with the following tables.

TABLE I

Group A – Lot by lot

Sub-group	Examination or test	IEC publication	Details and conditions
A1	External visual examination	Subclause 4.2.1.1 of the generic specification	
A2a	Inoperative		To be specified
A2b, A3, A4	Electrical and optical characteristics	See relevant part of IEC Publication 747-5	To be specified in accordance with the applicable methods

TABLE II

Group B – Lot by lot
(in the case of category I, see the generic specification, subclause 2.6)

Sub-group	Examination or test	IEC publication	Details and conditions
B1	Dimensions (interchangeability)	—	In accordance with the drawing given in the detail specification (see also appendix B)
B2a	Electrical and optical characteristics (design parameters)	See relevant publication	To be specified, where appropriate
B2b	Other electrical and optical characteristics	See relevant publication	To be specified, where appropriate; for example high-temperature measurements
B2c	Verification of electrical and limiting values	See relevant publication	To be specified, where appropriate
B3	—	—	Not applicable
B4	Solderability	749, ch. II, subcl. 2.1	To be specified
B5a	Rapid change of temperature, followed by either: Damp heat, cyclic or: Sealing	749, ch. III, cl. 1 749, ch. III, cl. 4 749, ch. III, cl. 7	To be specified, depending on encapsulation
B5b	Changes of temperature (see note)	68-2-14, cl. 2, Test Nb	To be specified (detection of intermittent failures)
B6	—	—	Not applicable
B7	—	—	Not applicable
B8	Electrical endurance	See relevant publication	168 h, method to be specified
B9	—	—	Not applicable
Sub-group CRRL	Certified records of released lots, where appropriate	—	Attributes information as specified in the blank detail specification

NOTE – Applicable only to pigtail devices where optical coupling material is in direct contact with the die surface or interconnecting leads.

TABLE III
Group C – Periodic

Sub-group	Examination or test	IEC publication	Details and conditions
C1	Dimensions	—	In accordance with the drawing given in the detail specification (see also appendix B)
C2a	Electrical and optical characteristics (design parameters)	See relevant publication	To be specified
C2b	Other electrical and optical characteristics	See relevant publication	To be specified: for example, measurements at temperature limits
C2c	Verification of electrical and optical limiting values	See relevant publication	To be specified
C2d	Thermal resistance, junction-to-case	Under consideration	To be specified
C3	Robustness of terminations	749, ch. II, cl. 1	To be specified: for example, tensile or torque (see note)
C4	Resistance to soldering heat	749, ch. II, subcl. 2.2	To be specified
C5	Rapid changes of temperature, followed by either: Damp heat, cyclic or: Sealing	749, ch. III, cl. 1 749, ch. III, cl. 4 749, ch. III, cl. 7	To be specified, depending on encapsulation
C6	Mechanical shocks or Vibrations, or Acceleration, steady-state	749, ch. II, cl. 4 749, ch. II, cl. 3 749, ch. II, cl. 5	To be specified, depending on encapsulation (if required by the blank detail specification)
C7	Damp heat, steady-state or: Damp heat, cyclic	749, ch. III, cl. 5 749, ch. III, cl. 4	To be specified, depending on encapsulation
C8	Electrical endurance or equivalent accelerated stress testing	See relevant publication	1 000 h, conditions to be specified
C9	Storage at high temperature	749, ch. III, cl. 2	1 000 h, at maximum storage temperature
C10	—	—	Not applicable
C11	Permanence of marking	749, ch. IV, cl. 2	To be specified
Sub-group CRRL	Certified records of released lots, where appropriate	—	Attributes information as specified in the blank detail specification

NOTE - Not applicable to microminiature devices.

3.5 *Group D tests*

These tests shall be performed for qualification approval only. Where required, they shall be prescribed in the detail specification.

3.6 *Screening*

When screening is specified in the detail specification or the order, it shall be applied to all devices in the production lot in accordance with table IV.

Screening is normally performed before Groups A, B and C inspection. When screening is performed after meeting the requirements of Groups A and B on a lot by lot basis and Group C on a periodic basis, the solderability, sealing and Group A tests shall be repeated.

Additional post-screening tests may be required as specified in the detail specification.

Sequences for screening shall be in accordance with table IV below.

TABLE IV (under consideration)

Screening

Steps	Examination or test	IEC publication	Details	Screening sequence				
				A	B	C	D	E

3.7 Sampling requirements

TABLE V
Sampling requirements for Group A tests*

Sub-group	LTPD (note 3)			AQL (note 1)					
	Category I	Category II	Category III	Category I		Category II		Category III	
				IL	AQL	IL	AQL	IL	AQL
A1	5	5	5	I	0,65	I	0,65	I	0,65
A2a (notes 2, 4)									
3 terminals or more	1,0	1,0	1,0	II	0,15	II	0,15	II	0,15
2 terminals	0,7	0,7	0,7	II	0,10	II	0,10	II	0,10
A2b (notes 2, 4)									
3 terminals or more	5	5	3	II	0,65	II	0,65	II	0,4
2 terminals	3	3	2	II	0,4	II	0,4	II	0,25
A3	7	7	7	S4	1,0	S4	1,0	S4	1,0
A4	20	20	20	S3	2,5	S3	2,5	S3	2,5

* For categories of assessed quality, see subclause 2.6 of the generic specification.

NOTES

- 1 The AQL values apply to the total number of defective devices in each sub-group.
- 2 If LTPD is selected for Group A tests, it is permitted to use AQL for sub-group A2 only.
- 3 Lot Tolerance Per cent Defective, with a maximum acceptance number of 4.
- 4 If it is demonstrated by 100 % testing that the number of defective devices in a lot is less than 0,1 %, no outgoing sample inspection of electrical and optical parameters in this sub-group is required for that lot.

TABLE VI
*Sampling requirements for Groups B and C tests,
in which LTPD shall be used**

Sub-group	LTPD (note)					
	Categories I and II	Category III				
		Screening sequence				
		A	B	C	D	E
B1	15	15	15	15	15	15
C1	30	30	30	30	30	30
B2a, B2b, B2c, C2a	15	15	15	15	15	15
C2b	15	15	15	15	15	15
C2c	15	15	15	15	15	15
C2d	20	20	20	20	20	20
B3 C3	15	15	15	15	15	15
B4 C4	15	15	15	15	15	15
B5a, B5b C5	20	20	20	20	20	20
B6 C6	20	20	20	20	20	20
B7 C7	20	20	20	20	20	20
B8 C8	10	5	7	10	7	10
B9 C9	15	5	7	10	7	10

* For categories of assessed quality, see subclause 2.6 of the generic specification.

NOTE - Lot Tolerance Per cent Defective, with a maximum acceptance number of 4.

4 Test and measurement procedures

The methods listed below, with reference to the relevant IEC documents or publications, shall be used when required by the detail specification and as prescribed in the latter document (see subclause 4.3 of the generic specification).

4.1 Light emitting diodes, infrared emitting diodes, general measurements

Reference	Symbol	Title	IEC method (or as described in the referenced documents)
L-001	$\left\{ \begin{array}{l} I_v \\ I_e \end{array} \right.$	Luminous intensity Radiant intensity	IEC 747-5, ch. IV, subcl. 1.1 IEC 747-5, ch. IV, subcl. 1.2
L-003	$\left\{ \begin{array}{l} \lambda_p \\ \Delta\lambda \end{array} \right.$	Peak-emission wavelength and spectral radiation bandwidth	IEC 747-5, ch. IV, subcl. 1.4
L-004	$\left\{ \begin{array}{l} \theta_{1/2} \\ \Delta\theta \end{array} \right.$	Half-intensity angle and misalignment angle	IEC 747-5, ch. IV, subcl. 1.11
L-005	t_{on}, t_{off}	Switching times	IEC 747-5, ch. IV, subcl. 1.5
L-006	V_F	Forward voltage	IEC 747-3, ch. IV, sect. one, cl. 2
L-007	I_R	Reverse current	IEC 747-3, ch. IV, sect. one, cl. 1
L-008	C_{tot}	Total capacitance	IEC 747-3, ch. IV, sect. one, cl. 3
L-009	$\left\{ \begin{array}{l} \Phi_v \\ \Phi_e \end{array} \right.$	Luminous flux and Radiant flux (power)	IEC 747-5, ch. IV, subcl. 1.3
L-010	I_F	Forward current	IEC 747-5, ch. IV, subcl. 1.3
L-011	f_c	Cut-off frequency	IEC 747-5, ch. IV, subcl. 1.6

4.2 Photocouplers

Reference	Symbol	Title	IEC method (or as described in the referenced documents)
C-001	$V_{CEO(sus)}$	Collector-emitter sustaining voltage	Under consideration
C-002	$V_{(BR)ECO}$	Emitter-collector breakdown voltage	Under consideration
C-003	$V_{(BR)CBO}$	Collector-base breakdown voltage	} IEC 747-7, ch. IV, One, cl. 10
C-004	$V_{(BR)EBO}$	Emitter-base breakdown voltage	
C-005	$V_{CE(sat)}$	Collector-emitter saturation voltage	IEC 747-5, ch. IV, subcl. 3.6
C-006	V_{IO} or V_{IORM}	Continuous or repetitive peak isolation voltage (test)	IEC 747-5, ch. IV, subcl. 3.4
C-007	V_{IOSM}	Surge isolation voltage (test)	Under consideration
C-008	I_{CEO}	Collector-emitter cut-off current	IEC 747-7, ch. IV, One, cl. 3
C-009	I_{CBO}	Collector-base cut-off current	IEC 747-7, ch. IV, One, cl. 2
C-010	$h_{F(ctr)}$	Current transfer ratio	IEC 747-5, ch. IV, subcl. 3.1
C-011	h_{FE}	Static value of the forward current transfer ratio	IEC 747-7, ch. IV, Two, cl. 7
C-012	r_{IO}	Isolation resistance between input and output	IEC 747-5, ch. IV, subcl. 3.3
C-013	C_{io}	Input-to-output capacitance	IEC 747-5, ch. IV, subcl. 3.2
C-014	t_{on}, t_{off}	Switching times	IEC 747-5, ch. IV, subcl. 3.7
C-015		Partial discharge	IEC 747-5, ch. IV, subcl. 3.5

4.3 Laser diodes

Reference	Symbol	Title	IEC method (or as described in the referenced documents)
L-021	RIN	Relative intensity noise	IEC 747-5, ch. IV, subcl. 1.8
L-022	I_{th}	Threshold current	IEC 747-5, ch. IV, subcl. 1.7
L-023	λ_p	Peak emission wavelength	} IEC 747-5, ch. IV, subcl. 1.4
L-024	$\Delta\lambda$	Spectral radiation bandwidth	
L-025	N	Number of longitudinal modes	
L-026	ϕ_e	Radiant flux (power)	IEC 747-5, ch. IV, subcl. 1.3
L-027	W	Emission source size	} IEC 747-5, ch. IV, subcl. 1.9
L-028	d_a	Astigmatism	
L-029	$\theta_{1/2}$	Half-intensity angle	} IEC 747-5, ch. IV, subcl. 1.11
	$\Delta\theta$	Misalignment angle	
L-030	t_{on}, t_{off}	Switching times	IEC 747-5, ch. IV, subcl. 1.10

4.4 Photodiodes and phototransistors

Reference	Symbol	Title	IEC method (or as described in the referenced documents)
P-001	$I_{R(H)}, I_{R(e)}$	Reverse current under optical radiation of photodiodes	} IEC 747-5, ch. IV, subcl. 2.1
	$I_{C(H)}, I_{C(e)}$	Collector current under optical radiation of phototransistors	
P-002	$I_R, I_{CEO}, I_{ECO}, I_{EBO}$	Dark currents	IEC 747-5, ch. IV, subcl. 2.2
P-003	$V_{CE(sat)}$	Collector-emitter saturation voltage	IEC 747-5, ch. IV, subcl. 2.3
P-004	$t_r, t_f, t_{on}, t_{off}$	Switching times	IEC 747-5, ch. IV, subcl. 1.4
P-005	C_{tot}	Total capacitance (photodiodes)	IEC 747-3, ch. IV, sect. one, cl. 11
P-006	f_c	Cut-off frequency	IEC 747-5, ch. IV, subcl. 2.6
P-007	NEP	Noise equivalent power	IEC 747-5, ch. III, cl. 9
	I_N	Noise current	IEC 747-5, ch. III, cl. 9
P-008	—	Multiplication factor	IEC 747-5, ch. IV, subcl. 2.7
P-009	—	Excess noise factor	IEC 747-5, ch. IV, subcl. 2.5

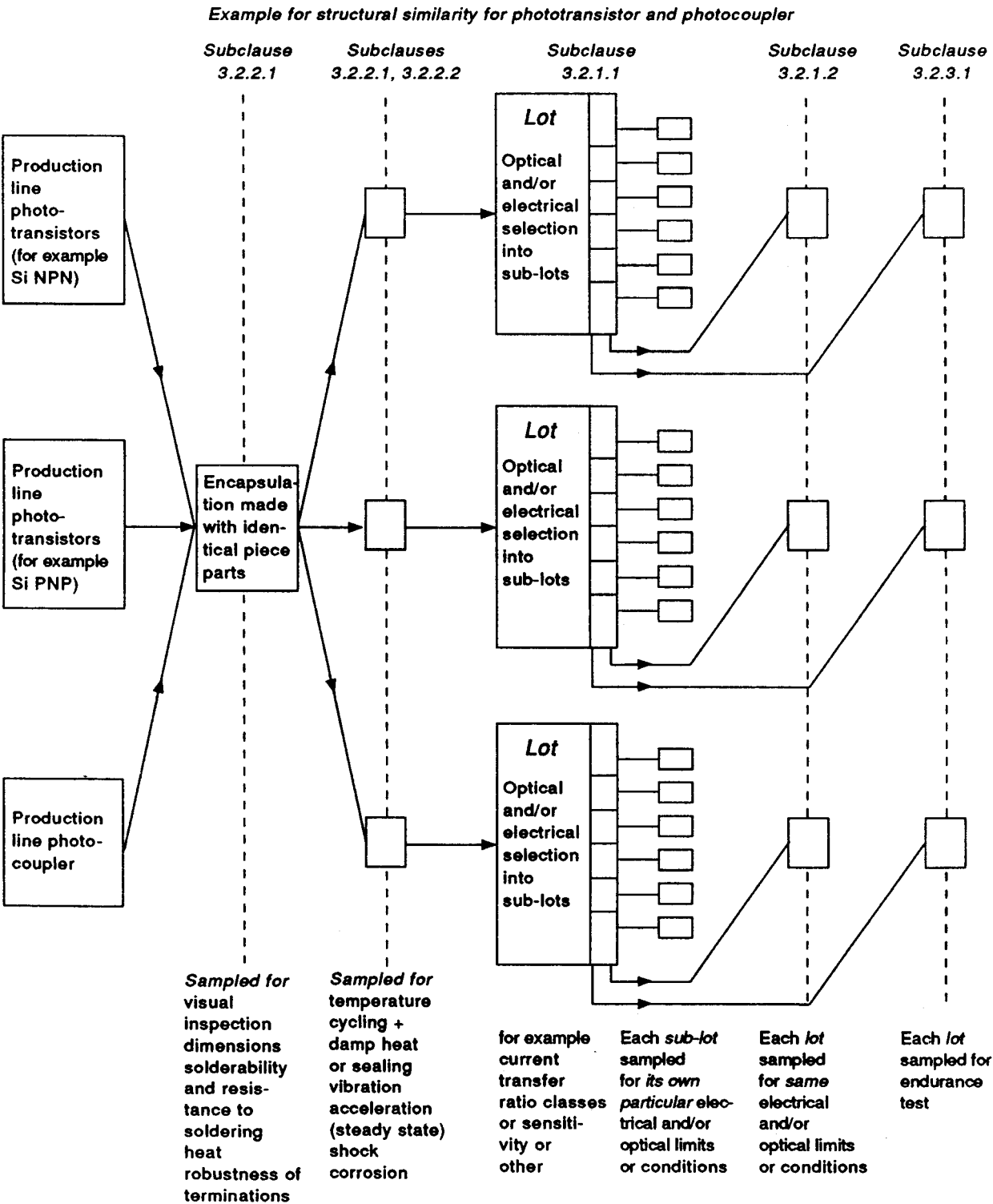
4.5 Other devices

(Under consideration.)

Appendix A
Structural similarity

The diagrams shown below give examples illustrating how structural similarity can be applied in practice.

– Diagram I: Example for phototransistor and photocoupler.



Appendix B

Dimensions

B.1 Package outline dimensions

This appendix give the list of dimensions to be checked as part of Groups B and C. Such dimensions are indicated by the standardized letters of IEC 191-1 and 191-2, to which reference is made.

Configuration of devices (IEC)	Group B	Group C
(1) Wire-mounted single-ended, for example C4 with base B4A (TO5)	O D A	All*
(2) Stud-mounted lug-ended, for example A4U (DO5) or A14U (TO65)	O D J	All* All*
(3) Flat-base mounted, for example C14A with base B18 (TO3)	U ₁ U ₂ q A	All*
(4) Other packages to be defined in conjunction with the relevant detail specification.		

All dimensions included in the IEC Publication 191-2 drawing called up in the detail specification, or in the drawing given in the detail specification prepared in accordance with IEC Publication 191-1, except those already covered in Group B.

B.2 Optically related dimensions

Where applicable, optically related dimensions and the group in which they are measured shall be given in the detail specification.

Appendix C

Directions of applied forces for mechanical tests

Orientation

For those test methods that involve the application of external forces related to the orientation of the device, such orientations and directions of forces applied shall be in accordance with figures 4 and 5 of IEC Publication 747-10, appendix C or figures 1 and 2 below.

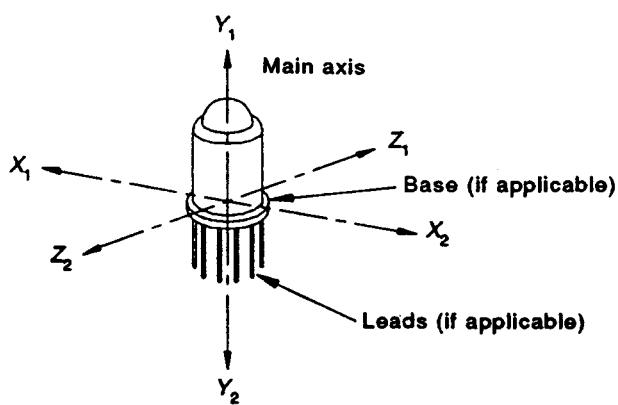


Fig. 1 – Orientation of a cylindrical device to direction of applied force.

Other packages to be defined in conjunction with the relevant detail specification.

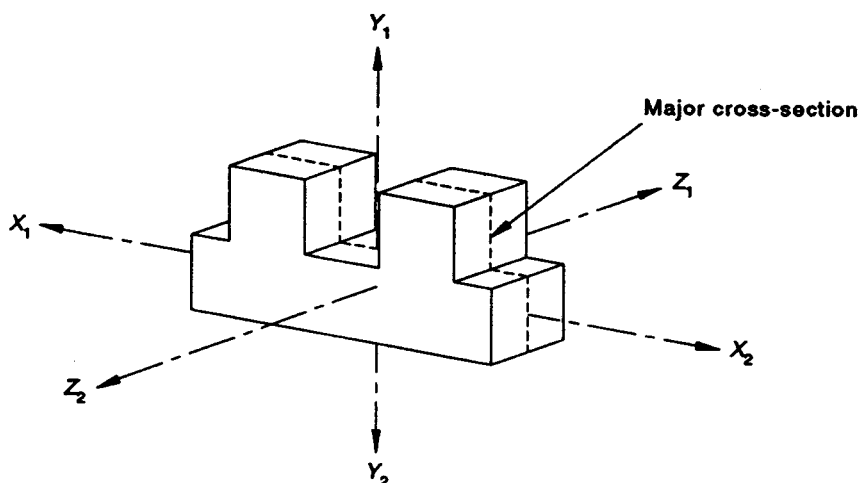


Fig. 2 – Other type of package.

(Continued from second cover)

IEC 191-1 (1966)	Mechanical standardization of semiconductor devices — Part 1 : Preparation of drawings of semiconductor devices
IEC 191-2 (1966)	Mechanical standardization of semiconductor devices — Part 2 : Dimensions
IEC 747-2 (2000)	Semiconductor devices — Discrete devices — Part 2 : Rectifier diodes
IEC 747-5 (1991)	Semiconductor devices — Discrete devices — Part 5 : Optoelectronic devices
IEC 749 (1984)	Semiconductor devices — Mechanical and climatic test methods

Only the English language text of the International Standard has been retained while adopting it in this Indian Standard.

Bureau of Indian Standards

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Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

This Indian Standard has been developed from Doc : No. LTD 10 (49).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters :

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110 002
Telephones : 323 01 31, 323 33 75, 323 94 02

Telegrams : Manaksanstha
(Common to all offices)

Regional Offices :

	Telephone
Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg NEW DELHI 110 002	{ 323 76 17 323 38 41
Eastern : 1/14 C. I. T. Scheme VII M, V. I. P. Road, Kankurgachi CALCUTTA 700 054	{ 337 84 99, 337 85 61 337 86 26, 337 91 20
Northern : SCO 335-336, Sector 34-A, CHANDIGARH 160 022	{ 60 38 43 60 20 25
Southern : C. I. T. Campus, IV Cross Road, CHENNAI 600 113	{ 235 02 16, 235 04 42 235 15 19, 235 23 15
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